Original Article

Laparoscopic Common Bile Duct Exploration: Our First 50 Cases

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Abstract

Introduction: Laparoscopic common bile duct exploration (CBDE) is becoming more popular in the management of choledocholithiasis due to improved laparoscopic expertise and advancement in endoscopic technology and equipment. This study aimed to evaluate the safety and short-term outcome of laparoscopic CBDE in a single institution over a 3-year period. Materials and Methods: A retrospective review of the records of all patients who underwent laparoscopic CBDE in Tan Tock Seng Hospital between January 2006 and September 2008 was conducted. Results: Fifty consecutive patients, with a median age of 60 years (range, 27 to 85) underwent laparoscopic CBDE for choledocholithiasis during the study period. About half of our patients presented as an emergency with acute cholangitis (32.0%) accounting for the majority. A total of 22 (44.0%) patients underwent laparoscopic CBDE as their primary procedure while the remaining 28 (56.0%) were subjected to preoperative ERCP initially. Of the latter group, documented stone clearance was only documented in 5 (17.9%) patients. Laparoscopic CBDE via the transcystic route was performed in 27 (54.0%) patients while another 18 patients (36.0%) had laparoscopic choledochotomy and 1 patient (2.0%) had laparoscopic choledocho-duodenostomy. There were 4 (8.0%) conversions in our series. The median operative time for laparoscopic CBDE via the transcystic route and the laparoscopic choledochotomy were 170 (75-465) and 250 (160-415) minutes, respectively. For the 18 patients who underwent a laparoscopic choledochotomy, T-tube was inserted in 8 (44.4%) patients while an internal biliary stent was placed in 4 (22.2%) with the remaining 6 patients (33.3%) undergoing primary closure of the choledochotomy. The median length of hospital stay was 2 days (range, 1 to 15) with no associated mortality. The main complications (n = 4, 8.0%) included retained CBD stones and biliary leakage. These were treated successfully with postoperative endoscopic retrograde cholangiopancreatography (ERCP) with/without percutaneous drainage with no further surgery required. Conclusion: Laparoscopic CBDE is a safe operation with good outcome in managing choledocholithasis. Its dividends include the numerous benefits of minimally invasive surgery. If possible, transcystic extraction is preferred to choledochotomy, as this obviates the need for biliary diversion. ERCP will still hold an important role in certain instances in the management of choledocholithiasis.

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Key words: Common bile duct stones, Laparoscopy

Introduction

Since its introduction a few decades ago, endoscopic retrograde cholangiopancreatography (ERCP) has brought about a significant change in the management of choledocholithiasis.[1] With continual improvement in the technology and expertise in laparoscopic techniques, laparoscopic common bile duct exploration (CBDE) is becoming more popular and may be the next paradigm in the management of choledocholithiasis.[2]

Laparoscopic CBDE is more desirable due to several important reasons.[3,4] Firstly, it removes the need and hence the risks of ERCP, which includes haemorrhage, duodenal perforation and pancreatitis. Secondly, it reduces the inconvenience by offering a one-stage procedure in laparoscopic CBDE compared to a two-stage approach in ERCP followed by laparoscopic cholecystectomy.

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Furthermore, the results of laparoscopic CBDE are also comparable to the conventional two-stage approach.[3]

In our institution, ERCP with subsequent laparoscopic cholecystectomy has been the preferred approach for the treatment of choledocholithiasis for numerous years, but over the past 3 years, laparoscopic CBDE has been offered to patients with suspected choledocholithiasis. The aim of this article is to report our institution's initial experience in laparoscopic CBDE in choledocholithiasis with regard to the safety profile and short-term outcome following the operation.

Materials and Methods

Study Population

A retrospective review of a prospective electronic database of all patients who underwent laparoscopic CBDE in our institution between January 2006 and September 2008 was performed. All the laparoscopic CBDE operations were performed by or supervised by a consultant from the Hepatobiliary team. Tan Tock Seng Hospital is a 1300-bed hospital, the second largest in Singapore and provides secondary and tertiary medical care for about 1.5 million people.

Patients with choledocholithiasis could present either as an emergency or in an elective setting. Patients with cholangitis would first undergo emergency ERCP (or percutaneous transhepatic cholangiography should ERCP fails) to decompress the biliary system and relieve the hepatobiliary sepsis as recommended by the Tokyo guidelines.[4] Upon resolution of the infection, these patients would be offered laparoscopic cholecystectomy with laparoscopic CBDE if the initial ERCP had not cleared the stones or the conventional two-stage procedure. Laparoscopic CBDE would also be offered to all elective patients with choledocholithiasis and in whom ERCP failed to ensure stone clearance. In this current series, patients who had successful ERCP and subsequent laparoscopic cholecystectomy were not included. Figure 1 highlights our institution's approach to choledocholithiasis in an emergency setting, while Figure 2 illustrates the elective management.

Data collected include the patients' biodata, underlying medical conditions, American Society of Anesthesiologists (ASA) status, initial presentation, results of their haematological and radiological investigations, and whether ERCP was performed prior to the surgery. Details of the surgery and the short-term outcomes were also acquired. Complications were graded according to the system described by Dindo et al.[5]

Operative Technique

Laparoscopic cholecystectomy was carried out under general anaesthesia with the patient positioned supine. All patients received routine prophylactic antibiotics according to our institution's surgical site infection prevention protocol. The positions of the 4 ports are as for standard laparoscopic cholecystectomy. These are sited at the infraumbilical area (10 mm), subxiphoid (5 mm), and 2 over the right subcostal area (5 mm). An additional 5 mm port would be inserted at the left flank or iliac fossa to help in intracorporeal suturing for closure of choledochotomy if required. Transcystic intraoperative cholangiography (IOC) was always performed first to confirm the presence of CBD calculi and their location before proceeding with

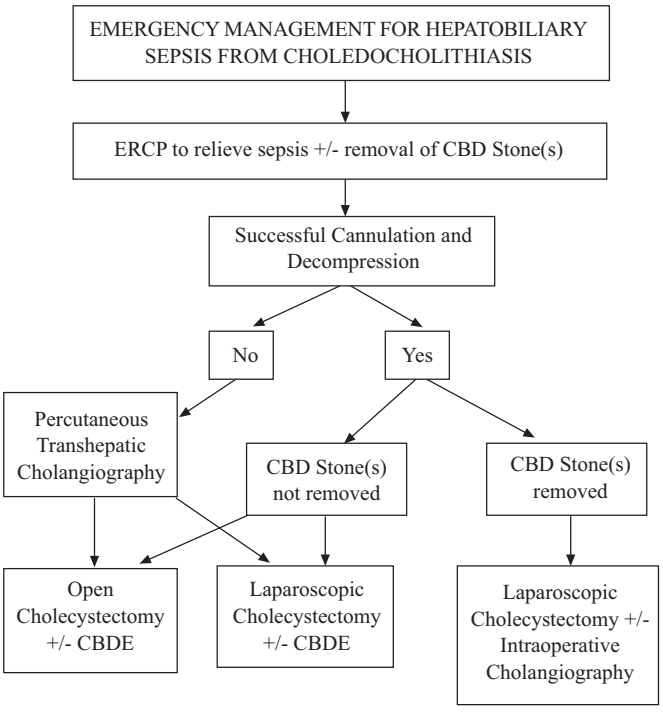

Fig. 1. Management of choledocholithiasis in an emergency setting.

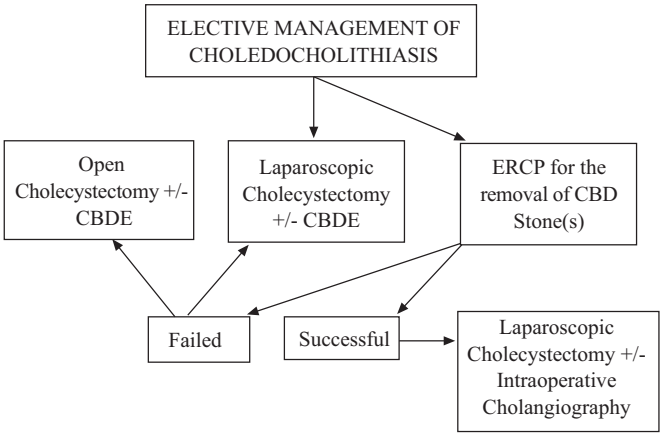

Fig. 2. Management of choledocholithiasis in an elective setting.

exploration using one of the following techniques. Care was taken to avoid the introduction of air bubbles during the performance of the IOC.

Transcystic Laparoscopic CBDE – Basket Extraction under Fluoroscopic Visualisation

Our preferred choice for laparoscopic CBDE is to use the transcystic route. For this approach, the default technique is to perform a transcystic exploration using the 5.5-Fr Nathanson basket kit (Cook Australia, Eight-Mile Plains, Queensland, Australia) under image intensification. Under fluoroscopic control, the basket was pushed proximally towards the duodenum, opened and retracted near the stone to capture it and remove it through the cystic duct. The process would be repeated until all stones were cleared.

Transcystic Basket Extraction Using Choledochoscopy

Should the above technique fail, we would then attempt a transcystic choledochoscopy so as to remove the stone under direct vision. Stone removal is performed using the ZeroTip Nitinol Stone Retrieval Basket (Boston Scientific-Microvasive, Natick, Massachusetts) through the working channel of the 2.8 mm choledochoscope. First, after visualisation of the calculus from the choledochoscope, the basket would be introduced and after engaging the calculus, both the basket and the choledochoscope would be withdrawn in unison and the process repeated until complete clearance of stone.

Transcholedochal Laparoscopic CBDE

This is preferred when there are multiple or large stone(s), and usually in the presence of a dilated CBD (>10 mm). A longitudinal choledochotomy was performed using cutting diathermy and scissors after adequate exposure of the supra-duodenal CBD. Choledochoscopy using the 5 mm choledochoscope and basket extraction of calculi would be performed until complete clearance of stones. In our institution, biliary decompression after exploration was achieved by insertion of a T-tube or placement of an internal biliary stent based on the surgeon's preference. The choledochotomy could also be closed primarily. Interrupted sutures using 3/0 polyglactin would be used to close the choledochotomy laparoscopically.

A completion cholangiogram was routinely performed following a transcystic exploration. However, for patients who had a bile duct exploration by a choledochotomy, verification of complete stone clearance was either by a completion cholangiogram or a choledochoscopy, according to the preference of the attending surgeon.

Placement of an abdominal drain was up to the surgeons' preference. If a drain was placed, it would be sited in the sub-hepatic space at the end of the surgery. In this series, biliary leak was defined as having one or more of the following: (i) any bilious peritoneal drainage beyond the third postoperative day, (ii) bilious drainage of more than 50 mL any day postoperatively, (iii) re-operation for biliary peritonitis or (iv) radiological drainage of a biloma.

Postoperative Evaluation

If a T-tube was inserted, cholangiogram would be performed through the T-tube on the seventh postoperative day. This can be performed as an outpatient procedure, and if the cholangiogram was cleared of any calculus, the T-tube would be spigoted and later removed at 4 to 6 weeks. For those who had an internal biliary stent inserted, these would be removed endoscopically in about 4 to 6 weeks postoperatively as a day case in our endoscopy centre.

Results

A total of 50 consecutive patients, with a median age of 60 years (range, 27 to 85) underwent laparoscopic CBDE for choledocholithiasis from January 2006 to September 2008 (Table 1). The majority were female (68.0%) and

Table 1. Characteristics of the 50 Patients who Underwent Laparoscopic CBDE

	No. of patients (%)
Median age (y)	60 (range 27-85)
Gender	
Male	16 (32.0)
Female	34 (68.0)
Racial distribution	
Chinese	41 (82.0)
Malay	7 (14.0)
Indian	1 (1.9)
Others	1 (1.9)
ASA status	
1	4 (8.0)
2	36 (72.0)
3	10 (20.0)
4	0
Presence of ≥1 comorbid condition(s)	31 (62.0)
Hypertension	25 (50.0)
Diabetes mellitus	10 (20.0)
Ischaemic heart disease	6 (12.0)
Asthma	2 (4.0)
Renal impairment	2 (4.0)
Previous abdominal surgery	4 (8.0)

ASA: American Society of Anesthesiologists; CBDE: common bile duct exploration

Table 2. Initial Presentation and Liver Function Test and the Diagnostic Modality Performed

	No. of patients (%)
Initial presentation	
Abdominal pain	30 (60.0)
Jaundice	23 (46.0)
Acute cholecystitis	5 (10.0)
Acute cholangitis	16 (32.0)
Acute pancreatitis	5 (10.0)
Asymptomatic	1 (2.0)
Liver function test on presentation (normal range)	
Median bilirubin (7-31 umol/L)	27 (range 6-300)
Median ALP (38-126 U/L)	148 (range 39-748)
Median AST (15-41 U/L)	48 (range 14-828)
Median ALT (17-63 U/L)	71 (range 11-815)
Diagnostic modality	
Ultrasound	40 (80.0)
CT scan	19 (38.0)
MRCP scan	18 (36.0)

CT: computed tomography; MRCP: magnetic resonance cholangiopancreatography

of Chinese ethnicity (82.0%). Hypertension is the most common medical co-morbidity in 50.0%, while 4 patients had a history of abdominal surgery.

At initial presentation, 60.0% presented with abdominal pain, while 46.0% had jaundice or deranged liver function tests. Acute cholangitis (32.0%) accounted for the majority of the emergency presentations, followed by acute pancreatitis (10.0%) and acute cholecystitis (10.0%). Ultrasound (80.0%) was the most commonly adopted imaging modality, followed by computed tomography (CT) (38.0%) and magnetic resonance cholangiopancreatography (MRCP) (36.0%). Table 2 illustrates the initial presentation, the associated liver function tests and the diagnostic modality used.

A total of 22 (44.0%) patients underwent laparoscopic CBDE as their primary procedure while the rest (n = 28, 56.0%) had a preoperative ERCP. However in those who underwent ERCP initially, cannulation of the CBD was only successful in 18 (64.3%) patients with sphincterotomy performed in 14 (50.0%) patients, insertion of biliary stent in 12 (42.9%), and stone clearance documented in only 5 (17.9%) patients (Table 3). Despite documented clearance of stone in these 5 patients, stones were still found in the CBD on IOC. This illustrates the problem of continual passage of stones from the gallbladder in the interval between ERCP and the subsequent cholecystectomy.

Table 3. Details of Preoperative ERCP

	No. of patients (%)
Number of patients who underwent ERCP	28
Successful Cannulation	18 (64.3)
Confirmation of CBD stone(s)	14 (50.0)
Sphincterotomy performed	14 (50.0)
Documented clearance of CBD	5 (17.9)
CBD stent insertion	12 (42.9)

CBD: common bile duct; ERCP: endoscopic retrograde cholangio-pancreatography

Surgery

Laparoscopic CBDE via the transcystic route was performed in 27 (54.0%) patients while another 18 (36.0%) had laparoscopic choledochotomy and 1 patient had laparoscopic choledocho-duodenostomy. This patient had to undergo choledocho-duodenostomy for recurrent ductal stones despite undergoing previous cholecystectomy several years ago. There were 4 (8.0%) conversions in our series.

Amongst the 27 patients who underwent transcystic approach of CBDE, 1 had a CBD stone that could not be removed despite multiple attempts. The surgeon opted for postoperative ERCP removal of the stone as the calculus was located in the common hepatic duct and the bile duct was deemed too small to allow a safe choledochotomy. The ERCP was successful.

The median operative time for laparoscopic CBDE via the transcystic route and the laparoscopic choledochotomy were 170 (range, 75 to 465) and 250 (range, 160 to 415) minutes, respectively. The median length of hospital stay was 2 (range, 1 to 15) days with no associated mortality.

Completion intraoperative cholangiogram was carried out in 36 (72.0%) patients, whilst the rest had a check choledochoscopy to ensure complete stone clearance. For the 18 patients who underwent a laparoscopic choledochotomy, T-tube was inserted in 8 (44.4%) patients while endobiliary stent was inserted in 4 (22.2%) with the remaining 6 patients (33.3%) undergoing primary closure of the choledochotomy.

Conversions

Out of the 4 conversions, 1 had contrast extravasation on the check cholangiogram that was due to a small perforation of the posterior aspect of the cystic duct that the surgeon interpreted as a CBD injury. Another was due to the dense adhesion around the CBD. The last 2 conversions were to retrieve the dropped stones which could not be located laparoscopically.

Table 4. Details of Surgical Findings

	No. of patients (%)
Type of intervention performed	
Transcystic laparoscopic CBDE with Nathanson set or choledochoscopy	27 (54.0)
Laparoscopic choledochotomy	18 (36.0)
Laparoscopic choledocho-duodenostomy	1 (2.0)
Laparoscopic converted open CBDE	4 (8.0)
Ductal drainage procedure	
T-tube insertion	8 (44.4)
Internal C-stent inserted	4 (22.2)
Primary closure of choledochotomy	6 (33.3)
Completion IOC done	36 (72.0)
Adhesions over the Calot's triangle	
Mild	27 (54.0)
Moderate	14 (28.0)
Severe	9 (18.0)
Adhesions over the CBD	
Mild	30 (60.0)
Moderate	14 (28.0)
Severe	6 (12.0)
Reasons for conversion from laparoscopic to open procedure	
Contrast extravasation on check IOC	1 (2.0)
Lost stone(s) in the peritoneum	2 (4.0)
Dense adhesion around the CBD after failed transcystic cannulation of catheter	1 (2.0)
Median operative time (minutes)	
Transcystic laparoscopic CBDE with Nathanson set or choledochoscopy	170 (range 75-465)
Laparoscopic choledochotomy	250 (range 160-415)
Median length of hospital stay (days)	2 (range 1-15)

CBD: common bile duct; CBDE: common bile duct exploration; IOC: intraoperative cholangiography

Table 5. Complications of the Laparoscopic CBDE in our Series

	No. of patients (%)
Complications	
Bile leak + retained stone	1 (2.0)
Bile leak	1 (2.0)
Retained stone	2 (4.0)
Wound infection	2 (4.0)
Chest infection	2 (4.0)

Complications

There were 4 patients with grade 3 complications.[5] The first patient underwent an uneventful transcystic laparoscopic CBDE and was discharged well. However, on the 5th postoperative day, she was re-admitted for fever and abdominal pain. An urgent CT scan revealed a sub-hepatic collection that necessitated percutaneous drainage and it confirmed a bile leak. ERCP was performed and a retained stone was removed. An internal biliary stent was placed to treat the leak.

Another patient who also underwent transcystic laparoscopic CBDE was diagnosed to have bile leak due to continual bile discharge from his abdominal drain postoperatively. However, this was managed conservatively and no further intervention was required.

The next patient underwent laparoscopic choledochotomy initially, but was converted to an open procedure due to lost stones from an inadvertent entry into the gallbladder. She subsequently developed intra-abdominal abscess that required percutaneous drainage. Check T-tube cholangiogram on the 7th postoperative day detected a retained stone which was subsequently removed by ERCP.

The last patient had a laparoscopic choledochotomy and closure of the bile duct over an internal biliary stent. During the scheduled removal of the stent, a retained stone was found and removed successfully. Other minor complications in our series included wound infection (n = 2, 4.0%) and chest infection (n = 2, 4.0%).

Hence, based on an intention-to-treat analysis, the stone clearance rate of our initial experience with laparoscopic CBDE was (total number of patients – conversions – retained stones – failure of transcystic extraction)/(total number of patients) x 100% = (50–4–2–1)/50 = 86%.

Discussion

Since the introduction of ERCP, most patients with CBD stones were managed by endoscopic stone extraction before laparoscopic cholecystectomy.[1] Should ERCP fail, patients are usually subjected to an open CBD exploration.

However, there are numerous criticisms of ERCP and endoscopic sphincterotomy. Firstly, cannulation of the CBD is not guaranteed, and some of the reasons cited include anatomical anomalies such as duodenal diverticulum next to the papilla, relative stricture below the CBD stone, Mirrizi's syndrome or previous Billroth II gastrectomy.[6,7] Furthermore, the immediate complications of ERCP include haemorrhage, pancreatitis and perforation, while some of the long-term issues include duodenal reflux, ascending cholangitis, papillary stenosis and recurrent stone formation.[6,7]

With significant advancement in endoscopic technology and equipment, and with improved expertise in laparoscopic

surgery, laparoscopic CBDE became a feasible option for choledocholithiasis. It proved to be highly effective, with associated good results.[2,3]

The success rate in performing laparoscopic CBDE in our series was 86% and is comparable to those reported in the literature.[2,3] Apart from the high success rate, the median length of stay in our series was a modest 2 days, also similar to the numerous reports in the literature.[3] Our success rate and the length of stay were at least comparable, if not better than when compared to the 2-stage approach of ERCP and subsequent laparoscopic cholecystectomy.[2,3] It also obviates the numerous risks attributed to ERCP.[3]

Besides the minimally invasive nature of laparoscopic CBDE, the relative short length of stay in our series was attributed to several other reasons: firstly, we have a dedicated nurse clinician who follows up with every patient after they were discharged and any suggestion of complication would be dealt with accordingly. Hence, we are fairly assured even though our patients are discharged early. Secondly, patients with T-tube are now able to have their cholangiogram as an outpatient within a week of the surgery and scheduled to see the surgeon a few days after. Thirdly, our institution has implemented a biliary care-path which describes a standardised care in the management of all these patients postoperatively and this allows both surgeons and nurse clinician to address any issues promptly.

Comparing the various techniques in performing laparoscopic CBDE, transcystic CBDE has been associated with fewer complications compared to choledochotomy.[8] However, choledochotomy is still advised in situations when there are multiple (>5) and/or large stones (>6 mm), if they are located above the cystic duct implantation and if instrumentation of the cystic duct is not possible.

The issue of biliary diversion after choledochotomy has posed significant challenges to surgeons worldwide. One option is to place a T-tube for biliary decompression to prevent breakdown of repair, and to allow subsequent cholangiogram and percutaneous lithotripsy if required. However, some of its complications include dislodgement and kinking of the tube.[9] Moreover, adhesion formation and T-tube tract formation after laparoscopic CBDE may not be as good as that after open surgery; hence, the T-tube tract probably requires a longer duration for maturation prior to its removal, which may cause much distress to the patient.

Placement of an internal biliary stent is an attractive alternative because it removed the inconvenience and disadvantages associated with a T-tube. However, stent-related complications such as migration and perforation are not uncommon.[10] It also necessitates an additional endoscopic session to remove the stent.

Primary CBD closure without any diversion is the other option. The fear of causing biliary stricture appeared inflated as careful selection of patients has not been associated with any significant adverse effect.[11]

Half of our conversions were due to numerous lost gallstones during the procedure. Retrieval of gallstones was aimed to reduce the associated complications, which include subphrenic abscesses and empyemas.[12,13] Despite several reports citing the low rate of complications in lost gallstones, every effort must still be made to avoid leaving any dropped gallstones in the peritoneal cavity.[12,13]

When gallstone spillage occurs during laparoscopic cholecystectomy, retrieval of the gallstones can be performed without conversion. However, this can be a laborious process, especially if the stones are numerous and small and fall between loops of bowel. The large and medium-size stones can be retrieved individually using the 10-mm grasping forceps and collected in a plastic retrieval bag intracorporeally. If there are multiple small stones, a suction device is extremely helpful. If the cause of the spillage is from a gallbladder perforation, an effort to close this defect should be performed as early as possible using either clips or sutures to minimise further spillage of bile and stones.[12,13]

The risk of retained stones following laparoscopic CBDE had been reported in up to 10% of cases.[14,15] Retained stones continued to be a significant complication in CBDE, whether performed opened or laparoscopically.[2,3] Fortunately, it was only present in 6.0% in our series. In the 3 patients with a retained stone, a completion cholangiogram was performed in 2 of the 3 patients, whilst a check choledoscopy was performed in the third patient. Our results notwithstanding, we would still recommend either a cholangiographic or choledochoscopic confirmation of complete stone clearance at the end of the operation. The other main complication in our series was biliary leak at 4.0%, not different from those reported in the literature.[2,3,14,15]

It is because of these complications that ERCP still has its role in this era of laparoscopic CBDE.[14-16] ERCP is important as a rescue tool for the management of postoperative biliary leak and for the extraction of retained and recurrent stones.[16] Furthermore, ERCP has been shown to be more beneficial in patients who initially present with cholangitis or severe pancreatitis.[2]

As expected, our initial operative time for both techniques in laparoscopic CBDE (transcystic and choledochotomy) is slightly more prolonged compared to the other bigger series.[3,15,17] As with any new techniques, this was to be expected. The authors believed that the operative time would shorten with more experience.

The authors have no doubt that laparoscopic CBDE will become the procedure of choice in choledocholithiasis except in certain circumstances. These include significant adhesions from previous upper abdominal surgeries, severe

cholangitis and/or pancreatitis and in high-risk patients. ERCP would be instrumental in the management of the above conditions.[16] Furthermore, ERCP is also indispensable in the management of post-CBDE complications such as retained CBD stones and biliary leak.[14,15]

From our initial experience, the authors found that laparoscopic CBDE is a safe procedure and can be associated with good outcome if performed meticulously. Longer operative times are expected as with any new techniques. The authors felt that biliary diversion using either T-tube or internal biliary stent is advised for all beginners so as to reduce the incidence of bile leak from the repair site. Primary closure of the choledochotomy should be reserved in selected cases.

Conclusion

Laparoscopic CBDE is a safe operation with good outcome in managing choledocholithasis. If possible, transcystic extraction is preferred to choledochotomy, and the choice of biliary diversion is still controversial. ERCP will still hold an important role in certain instances in the management of choledocholithiasis.

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